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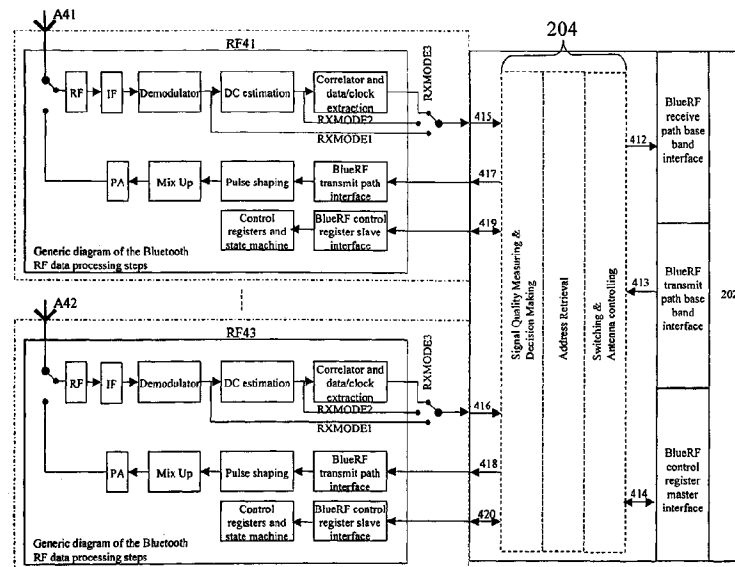
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(54) Title: A METHOD AND AN ARRANGEMENT FOR IMPLEMENTING COMMUNICATION BETWEEN DISTRIBUTED RADIO MODULES AND A SINGLE BASEBAND



(57) Abstract: The invention relates to a hardware interface and method which improve the coverage area for a radio system by using several RF devices simultaneously connected to a single baseband via the hardware interface. The hardware interface is adapted to connect the single baseband circuit to the plurality of Radio Frequency (RF) devices simultaneously, via the hardware interface, to receive a signal quality measurement from each of the RF devices that is connected to the baseband circuit to select the RF device having the highest signal quality, and to switch a communication to the selected RF device.

A method and an arrangement for implementing communication between distributed radio modules and a single baseband

FIELD OF INVENTION

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This invention relates to wireless distributed networks, and more particularly to a method and an arrangement for implementing communication between distributed radio modules and a single baseband.

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DESCRIPTION OF RELATED ART

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Low power radio frequency systems allow communication between devices over short distances typically ten's of meters. The devices must each be capable of receiving and transmitting according to the system's protocol.

20

One low power radio frequency system is the Bluetooth system. Such a system is described in the patent application document WO 0042744. This system is designed to replace connecting wires and cables with wireless connectivity. For one device to communicate with another device, no wires connecting them will be necessary. Instead, each device will host a transceiver. A transceiver has a baseband part and an RF part. The host itself may have a processing circuitry which is capable of doing the base band processing and that host will only require RF transceiver circuitry to be correctly connected to that processing circuitry.

25

The BlueRF specification describes the following features for an interface between Bluetooth RF transceiver (Phy) and base band devices:

30

- Physical interface signals
- Timing
- Electrical characteristics
- Behaviour.

The principal aims of the interface definition are to:

- Define a digital interface between the Phy and base band
- Enable use of the most effective process technologies and architectures on each side
- 5 of the interface boundary
- Provide guidelines as to how the Phy is controlled.

BlueRF is designed to be a scalable interface that allows implementers to optimise the Phy design for different levels of integration, pad count, and pad voltage. **Figure 1** provides
10 an overview of sections of a typical Bluetooth implementation and the RF data processing steps. Processes describing the BlueRF interface are shown in the grey boxes.

The Bluetooth standard specifies a receiving signal quality measure called Received Signal Strength Indicator (RSSI). When the baseband is in Receive Mode the voltage on the
15 RSSI (in case of analogue radio), or value of RSSI Register (in case of digital radio) indicates the Strength of received Signal. If it is above some threshold level then only the data received is qualified. Data is considered valid when the correlation of the received access code against the expected one rises above a trigger level. The point when this happens is used also to synchronise slave clocks. Internally an RSSI measurement may be
20 used by the radio section to adjust a front-end attenuator in the receive chain, but in the Bluetooth spec the RSSI is only ever used for power control.

To set up a power controlled link the transmit side must support Transmit Power Control and the receive side must support RSSI. Support is indicated in the Locally Supported Features (Bluetooth Spec 1.1 Part C (LMP) Section 3.11). The RSSI need only be able to
25 compare the incoming signal strength to two levels: the Upper and Lower Limits of the Golden Receiver Range. The Lower Limit is between -56 dBm and 6 dB above the receive sensitivity (0.1% Bit Error Rate (BER) level) for the particular implementation. The Upper Limit is 20 dB +/- 6 dB above this.

The RSSI level is monitored by the receive side's Link Controller. When it strays outside
30 the Golden Receiver range the Link Manager is notified. A Link Manager Protocol (LMP)

message is sent to the transmit side requesting an increase or decrease in transmit power to bring the RSSI back in line. The step size must be between 2 and 8 dB.

If the transmitter is a master it must maintain separate transmit powers for each slave. Host Controller Interface (HCI) commands exist to find out the current transmit power and RSSI level, but they are for information only. Layers above Link Manager are not directly involved in power control.

Support for Transmit Power Control is mandatory above +4 dBm - it must be controllable to less than +4 dBm. Below this level (i.e. all Class 2 and 3 modules) it is optional. Support for RSSI is always optional.

10 The implication of this is that it is perfectly possible to sit a Class 1 module transmitting at +20 dBm right next to another module which does not support RSSI and hence can not limit the first's transmit power. If the second module's maximum receivable level is the Bluetooth spec of -20 dBm there is every chance its RF front end will be overloaded. So, RSSI, although not mandatory, is highly recommended.

15

As mentioned above, the low power radio frequency systems allow communication between devices only over short distances.

20 SUMMARY OF THE INVENTION

The objective problem of the present invention is to provide a low power radio frequency system with an improved coverage area.

25 The provided hardware interface and method improve the coverage area for a radio system by using several RF devices simultaneously connected to a single baseband via the hardware interface. The hardware interface is adapted to connect the single baseband circuit to the plurality of Radio Frequency (RF) devices simultaneously, via the hardware interface, to receive a signal quality measurement from each of the RF devices that is
30 connected to the baseband circuit to select the RF device having the highest signal quality, and to switch a communication to the selected RF device.

An advantage with the present invention is that the signal quality is improved.

Another advantage of the present invention is that the use of a single multi-radio module i.e. an ordinary baseband and the baseband interface according to the present invention,
5 together with many simple cheap RF devices and antennas significantly lower the overall system cost and complexity.

BRIEF DESCRIPTION OF THE DRAWINGS

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Figure 1 shows prior art and is described above under "description of related art".

- Figure 1** is a diagram that shows the standard BlueRF - Bluetooth baseband interface according to prior art.
- 15 **Figure 2** depicts the use of multiple RF devices with individual antennas together with a hardware interface and a single baseband.
- Figure 3** depicts the use of multiple RF devices with individual controllable antennas together with a hardware interface according to the present invention and a single baseband.
- 20 **Figure 4** depicts the hardware interface according to the present invention in relation to the standard BlueRF - Bluetooth baseband interface.
- Figure 5** shows an exemplary deployment of the multi-radio module's components in relation to a building floor plan according to one embodiment of the invention.
- 25 **Figure 6** shows an exemplary deployment of the module's components in relation to a building floor plan according to one embodiment of the invention.
- Figure 7** depicts the incorporation of RF devices in a cable with connectors to a distant multi-radio module.
- Figure 8** depicts the incorporation of RF devices in a cable with connectors to a
30 distant multi-radio module.
- Figure 9** depicts the use of the in Figure 8 and 9, described cables to cover an entire building from the outside.

- Figure 10** depicts the use of the in Figure 8 and 9 described cables to cover an entire building from the inside.
- Figure 11** depicts the use of the setup in Figure 10 together with wireless devices inside the building, creating a super base station of the multi-radio module.
- 5 **Figure 12** shows an exemplary deployment of the module's components in relation to a street according to one embodiment of the invention.

DETAILED DESCRIPTION

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Figure 2 shows a low power radio frequency system according to the present invention, which system further on is called a multi-radio system. Low power radio frequency systems which can be used are for examples Bluetooth™, HomeRF™, HipertLAN/2, and IEEE Standard 802.11b. The system comprises a single baseband circuit 202, one or
15 more Radio Frequency (RF) devices RF21, RF22, and RF23 and a hardware interface 204 to connect the single baseband module 202 to one or more RF devices RF21, RF22, RF23. A user of a wireless terminal is connectable to the system via the RF devices.

Baseband circuit

20 The single baseband circuit 202 is an ordinary baseband, known from the art and is together with the RF device, i.e. the radio, constituting the physical layer according to the ISO 7-layer reference model for protocol software. The radio interfaces the air and the digital baseband. The baseband makes the physical RF link possible between wireless devices within a network and formats data for a robust and reliable transmission from
25 higher protocol layers to the radio for further transmission. It is responsible for encoding and decoding of data and low layer synchronisation between the devices and for handling of the radio link for the transmission of a data packet.

RF device

30 Each of the one or more RF devices RF21, RF22, RF23 comprises a RF transmitter and a RF receiver for transmitting and receiving data. Each of the one or more RF devices

RF21, RF22, RF23 performs signal quality measurements, which are transferred to the hardware interface 204.

Each of the RF devices RF21, RF22, RF23 further comprises an antenna A21, A22, and A23.

- 5 In a second embodiment of the present invention, some or each antenna A21, A22, and A23 includes steering capabilities such as antenna control devices. In **Figure 3** each of the antennas AC 31, AC22 and AC23 comprises a respective antenna control device AC 31, AC22 and AC23.

In a third embodiment (not shown), the antennas include different polarization.

10

Hardware interface

The baseband circuit 202 and the hardware interface 204 constitute a multi-radio module 206 and are connectable to a plurality of RF devices RF21, RF22, RF23 simultaneously.

- 15 The hardware interface 204 is further capable of receive a signal quality measurement from each of the RF devices that is connected to the baseband circuit 202, and to perform a selection, a majority or single selection of the RF device having the highest signal quality; and switch the communication to the selected RF device.

- 20 In case of Bluetooth™, the measured signal quality is received from the RF device as what is denoted as the Received Signal Strength Indicator (RSSI) in accordance with the BlueRF standard document or the Bluetooth™ Specification v1.0B or later version. This quality measure is normally used to control the strength of the transmission level to reach an optimal level, but the hardware interface 204 also allows control of which antenna is receiving the best signal and switch to this one when communicating with a current
25 device.

- To be capable of knowing which RF device, or in the case of Bluetooth™, which Bluetooth™ device the baseband is communicating with, one embodiment of the hardware interface 204 may comprise capabilities to retrieve the address of the other RF/Bluetooth™ devices it communicates with. It may further comprise means for storing
30 the retrieved addresses and maybe also the previous best signal way for the next communication slot.

The hardware interface constitutes a logic circuit, which could consider programmable hardware like for example Programmable Array Logic (PAL), Programmable Logic-Array (PLA), Programmable Logic Controller (PLC), Gate Array Logic (GAL), Programmable Logic Device (PLD), Electrically Programmable Logic Device (EPLD), Complex PLD (CPLD), Dynamically programmable gate array (DPGA), Field Programmable Logic-Array (FPLA), Field Programmable Gate Arrays (FPGA), etc., or custom made Application Specific Integrated Circuits (ASICs); however the use of a programmable device enables and ease interface enhancements and modifications.

In a second embodiment of the present invention, depicted in **Figure 3**, the hardware interface 204 has the additional functionality to control the individual antenna characteristics such as to phase shift the individual antennas and other methods to control the individual antenna characteristics. In this case the antennas to be controlled A21, A22 and A23 each has an antenna control device AC31, AC32 and AC33.

It is also possible to use a diversity scheme collecting the several signals analogous to create a single signal with better quality.

With this solution using a hardware interface in the form of a single logic circuit to enhance the interface between the baseband and several antennas with RF devices, the problem with handover between different devices can be eliminated partially or completely. Instead of switching between different basebands and their antennas when the communication drops in signal quality due to mobility of the users, creating much overhead in traffic and added system complexity, the hardware interface 204 according to the present invention automatically switches between the receiving RF device choosing the one (or the ones in a true diversity scheme) with the best signal quality

The hardware interface 204 will act as a completely transparent interface according to the interface specification and the standard communication protocol between the RF device and the Baseband (in the case of Bluetooth™ the so called BlueRF) enabling to connect several standard RF devices to a standard baseband. There will hence be no extra need for

processing in the baseband since it will not know that it is used together with several RF devices, enabling the use of ordinary components not specifically designed for diversity purposes. The use of a single multi-radio module i.e. an ordinary baseband and the baseband interface according to the present invention, together with many simple cheap
5 RF devices and antennas has potential to significantly lower the overall system cost and complexity.

Figure 4 depicts one example of the schematics of the hardware interface 204 according to the present invention, implemented in a Bluetooth™ system. The RF devices RF41 and
10 RF42 with their individual antennas A41 and A42 are connected to the baseband via the BlueRF interface and the hardware interface 204.

The number of possible connected RF devices depends on the number of I/O's and the number of gates inside the logic circuit. Each RF device interface requires approximately 10-15 connections.

15 Reference number 412 represents the receiving (RX) baseband interface; 413, the transmitting (TX) baseband interface; and 414, the control baseband interface. The required interface consists of the RX path 415 and 416 for receiving data, the TX path 417 and 418 for transmitting data and the control path 419 and 420 for selecting frequency channel and reading the signal quality measure (RSSI).

20 The Bluetooth standard only allow a master to communicate with a slave and vice versa. The communication protocol is divided into slot where the slave must respond the master during the next slot. The Address Retrieval module reads out the address of the slave from the data stream. The Signal Quality Measuring & Decision Making module reads the RSSI signal from the different RF devices and chooses the best path to switch to and
25 stores it for use during the next communication slot. The Switching & Antenna controlling controls the switching for the transmitting and receiving data channels and delivers data to the baseband 202. Meanwhile the invention should act transparently as there would be no device between the baseband 202 and the RF devices RF41 and RF42, such as if the baseband 202 was connected to a single RF device. However, extra
30 functionality within the baseband 202 can be allowed to ease and improve the functionality of the system.

Figure 5 shows an exemplary deployment of the multi-radio module's components in relation to a building floor plan according to one embodiment of the invention. It is shown a possible use of the present invention as would be to situate the different RF devices RF51, RF52 and RF53 and the antennas A51, A52 and A53 on different levels in a building switching between the different antennas and RF devices as a user using a portable RF entity connected to the system, changes level floor plan. The multi-radio module 500 includes the baseband circuit 202 and the hardware interface 204. In this example the multi-radio module 500 is connected to the three RF devices RF51, RF52 and RF53. The RF device RF51 including its antenna A51 is situated on a floor above the multi-radio 500 and is connected to the multi-radio 500 via a e.g. a cable 510. The RF device RF52 including its antenna A52 is co-located with the multi-radio module 500. The RF device RF53 is also co-located with the multi-radio module 500 but its antenna A53 is located at a floor beneath the multi-radio module 500 and connected to it via e.g. a cable 530. The respective arrow 501, 502 and 503 indicates the wireless coverage areas of the antennas A51, A52 and A53.

A user being on the third floor wishes to communicate via the multi-radio module 500. The hardware interface 204 within multi-radio module 500 receives signal quality measurements continuously or within certain time intervals from the three RF devices RF51, RF52 and RF53. The signal quality from RF51 is highest and therefore the communication is switched to that RF device and thus the user sends and receives data via the antenna A51 and the RF device RF51.

When the user walks down to the second floor, the signal quality from the RF device RF52 becomes higher than that from RF device RF51. The hardware interface 204 within the multi-radio 500 then switches the communication over to the RF device RF52 sending and receiving data through the antenna A52.

In the same way, when the user walks down to the first floor, the signal quality from the RF device RF53 becomes higher than that from RF device RF52 since RF53 located at the second floor has its antenna A53 located at the first floor. The hardware interface 204 within the multi-radio 500 then switches the communication over to the RF device RF53 for sending and receiving data through the antenna A53.

Figure 6 depicts an arrangement of the present invention as would be to situate the different RF devices RF61, RF62 and RF63 and the antennas A61, A62 and A63 in different corridors and rooms C1, C2 and R3 in a building, switching between the different antennas and RF devices as a user changes his position between different rooms.

5 The multi-radio module 600 including the hardware interface 204 (not shown) is connected to the three RF devices RF61, RF62 and RF63.

The wireless coverage areas of the antennas A61, A62 and A63 are indicated by the respective area 601, 602 and 603. Antenna A61 is located in corridor C1, antenna A62 is located in corridor C2 and antenna A63 is located in room R3.

10 A user being in the corridor C1 wishes to communicate via the multi-radio module 600. The hardware interface 204 within multi-radio module 600 receives signal quality measurements continuously from the three RF devices RF61, RF62 and RF63. The signal quality from RF61 is highest since the user is in the coverage area 601, and therefore the communication is switched to that RF device and thus the user sends and receives data
15 via the antenna A61 and the RF device RF61.

When the user walks to the corridor C2 the signal quality from the RF device RF62 becomes higher than that from RF device RF61. The hardware interface 204 within the multi-radio 600 then switches the communication over to the RF device RF62 sending and receiving data through the antenna A62.

20 In the same way, when the user walks into to the room R3, the signal quality from the RF device RF63 becomes higher than that from RF device RF62 since RF63, located in the corridor C2 has its antenna A63 located in room R3. The hardware interface 204 within the multi-radio 600 then switches the communication over to the RF device RF63 for sending and receiving data through the antenna A63.

25

Figure 7 depicts a possible integration of the small RF device RF71 with an omni directional antenna into a small cable 701 with connectors to a distant multi-radio module (not shown) and with an approximate diameter of a couple of cm. This cable consists of several RF devices interconnected to the baseband module having a certain length in
30 between and could be used e.g. as the arrangement depicted in Figure 9 and Figure 10.

Figure 8 depicts a possible integration of the small RF device RF81 including an directional antenna A81 into a small cable 801 with connectors to a distant multi-radio module (not shown) and with an approximate diameter of a couple of cm. This cable consists of several RF devices (not shown) interconnected having a certain length in
5 between and could be used e.g. as the arrangement depicted in Figure 9 and Figure 10.

Figure 9 depicts a possible use of the present invention as would be to situate the different RF devices RF91-RF96 coupled by RF device cable 90, and unnumbered RF devices coupled by cables 91-95 at different levels of the outside on a building.
10

Figure 10 depicts a possible use of the present invention as would be to situate the different RF devices RF101-105 having the respective coverage areas 101-105 inside a building 106. The RF devices RF101-105 are connected to the multi-radio module 100 by
15 means of a RF device cable 107.

Figure 11 depicts a possible use of the present invention as would be to situate the different RF devices RF91-96 from Figure 9, connected to the multi-radio module 1100, having the total coverage area CA110 inside the building. Inside the building several
20 separate communication modules 1101-1104 with antennas A111-A114 are located handling communication within coverage areas CA111-CA114. This ease the use of handover when a user moves between the different coverage areas CA111-CA114 as the user always switches to coverage area CA110, i.e., to a known device, when the user reaches the limit of the isolated coverage areas. For instance with Bluetooth™ it can take
25 up to 10-20s to connect to an unknown device and about only a tenth of the time to connect to a known device. Hence, the module 1100 will act as a super base station over the modules 1101-1104.

Figure 12 depicts a possible use of the present invention as would be to situate the different RF devices RF121-124 having the respective coverage areas CA121-124
30 covering a street. The RF devices RF121-124 are connected to the multi-radio module 1200. When USER31 moves on the right side of the street towards the module 1200 it is

first connected to RF device RF124 and when it passes coverage area CA124 into coverage area CA121 it is connected to the RF device RF121. The multi-radio module 1200 could be connected in a larger network by a wired 1201 or wireless connection (not shown). The same scenario applies for USER32 using RF devices RF122 and RF123 in
5 coverage areas CA122 and CA123. The data retrieved as of which RF device is currently used and which was used before, etc, can be retrieved and stored in a central database and used for instance for localization and tracking of the connected RF devices.

10 The method is implemented by means of a computer program product comprising the software code means for performing the steps of the method. The computer program product is run on processing means in a baseband circuit, a hardware interface and a plurality of RF devices, within the multi-radio system. The computer program product is loaded directly or from a computer usable medium, such as a floppy disc, a CD, the
15 Internet etc.

The present invention is not limited to the above-described preferred embodiments. Various alternatives, modifications and equivalents may be used. Therefore, the above embodiments should not be taken as limiting the scope of the invention, which is defined
20 by the appending claims.

CLAIMS

1. A hardware interface (204) between a single baseband circuit (202) and a plurality of Radio Frequency (RF) devices (RF21, RF22, RF23),
5 **characterised** in that it the hardware interface (204) is adapted to:
 - connect the single baseband circuit (202) to the plurality of Radio Frequency (RF) devices (RF21, RF22, RF23) simultaneously, via the hardware interface (204);
 - to receive a signal quality measurement from each of the RF devices that is connected to the baseband circuit (202);
 - 10 - to select the RF device having the highest signal quality; and
 - to switch a communication to the selected RF device.
2. The hardware interface (204) according to claim 1, wherein the selection is a majority selection.
- 15 3. The hardware interface (204) according to any of the claims 1-2, wherein it comprises means for retrieving and storing the addresses of each of the RF devices (RF21, RF22, RF23) connected to.
- 20 4. The hardware interface (204) according to any of the claims 1-3, wherein it comprises means for storing a previous best signal way for a next communication slot.
5. The hardware interface (204) according to any of the claims 1-4, wherein it constitutes a programmable hardware.
- 25 6. The hardware interface (204) according to claim 5, wherein the programmable hardware constitutes any of: Field Programmable Gate Arrays (FPGA), a Programmable Array Logic (PAL), a Programmable Logic-Array (PLA), a Programmable Logic Controller (PLC), a Gate Array Logic (GAL), a Programmable
30 Logic Device (PLD), an Electrically Programmable Logic Device (EPLD), a Complex

PLD (CPLD), a Dynamically programmable gate array (DPGA), or a Field Programmable Logic-Array (FPLA).

7. The hardware interface (204) according to any of the claims 1-4, wherein the hardware
5 constitutes an Application Specific Integrated Circuit (ASIC).
8. The hardware interface (204) according to any of the claims 1-7, wherein an RF device
(RF21, RF22, RF23) comprises an antenna (A21, A22, A23), which antenna comprises
a steering capabilities (AC31, AC32, AC33), the hardware interface further comprises
10 means for controlling the steering capabilities (AC31, AC32, AC33).
9. The hardware interface (204) according to any of the claims 1-8, wherein the single
baseband circuit (202), the plurality of RF devices (RF21, RF22, RF23) and the
hardware interface (204) uses Bluetooth™ technology.
15
10. The hardware interface (204) according to claim 9, wherein the hardware interface
(204) comprises means for receiving said signal quality measurement as a Received
Signal Strength Indicator (RSSI).
- 20 11. The hardware interface (204) according to any of the claims 1-8, wherein the single
baseband circuit (202), the plurality of RF devices (RF21, RF22, RF23) and the
hardware interface (204) uses any of the low powered radio frequency systems:
HiperLAN/2, IEEE 802.11b or HomeRF™.
- 25 12. A multi-radio module (206) comprising a single baseband circuit (202) and a hardware
interface (204) according to any of the claims 1-11, interfacing the single baseband
circuit (202).
13. The multi-radio module (206) according to claim 12, wherein it is used for localizing
30 and tracking connected devices.

14. A multi-radio system comprising a single baseband circuit (202), a plurality of RF devices (RF21, RF22, RF23) and a hardware interface (204) according to any of the claims 1-110, interfacing the single baseband circuit (202) and the plurality of RF devices (RF21, RF22, RF23).

5

15. The multi-radio system according to claim 14, wherein some of the to the single baseband connected RF devices (RF51, RF52) are located at different places.

10 16. The multi-radio system according to any of the claims 15-16, wherein the to the single baseband connected RF devices (RF 52, RF53) are co-located but their respective antenna (A52, A53) are located in different places.

15 17. Method for communicating in communications system comprising a plurality of RF devices (RF21, RF22, RF23) a single baseband circuit (202) and a hardware interface (204), between the plurality of RF devices (RF21, RF22, RF23) and the baseband circuit (202), the method comprising the following steps, to be taken by the hardware interface:

- *connecting* the single baseband circuit (202) to the plurality of Radio Frequency (RF) devices (RF21, RF22, RF23);
- 20 - *receiving* a signal quality measurement from each of the RF devices (RF21, RF22, RF23) that is connected to the baseband circuit (202);
- *selecting* the RF device having the highest signal quality; and
- *switching* a communication to the selected RF device,

25 18. The method according to claim 17, wherein the selection is a majority selection.

19. The method according to any of the claims 17-18, comprising the further step of *retrieving* and *storing* the addresses of each of the RF devices (RF21, RF22, RF23) connected to.

30

20. The method according to any of the claims 17-19, comprising the further step of
storing a previous best signal way for a next communication slot.
21. The method according to any of the claims 17-20, wherein an RF device (RF21, RF22,
5 RF23) comprise an antenna (A21, A22, A23), which antenna comprises a steering
capabilities (AC31, AC32, AC33), the method further comprising the steps of
controlling the steering capabilities (AC31, AC32, AC33).
22. The method according to any of the claims 17-21, wherein the single baseband circuit
10 (202), the plurality of RF devices (RF21, RF22, RF23) and the hardware interface
(204) uses Bluetooth™ technology.
23. The method according to claim 22, wherein the step of receiving said signal quality
measurement is performed as a Received Signal Strength Indicator (RSSI).
- 15 24. A computer program product directly loadable into the internal memory of a
processing means within a baseband circuit (202), a hardware interface (204) and a
plurality of RF devices (RF21, RF22, RF23) in a multi-radio system, comprising the
software code means for performing the steps of any of the claims 17-23.
- 20 25. A computer program product stored on a computer usable medium, comprising
readable program for causing a processing means in a baseband circuit (202), a
hardware interface (204) and a plurality of RF devices (RF21, RF22, RF23) in a multi-
radio system, to control an execution of the steps of any of the claims 17-23.

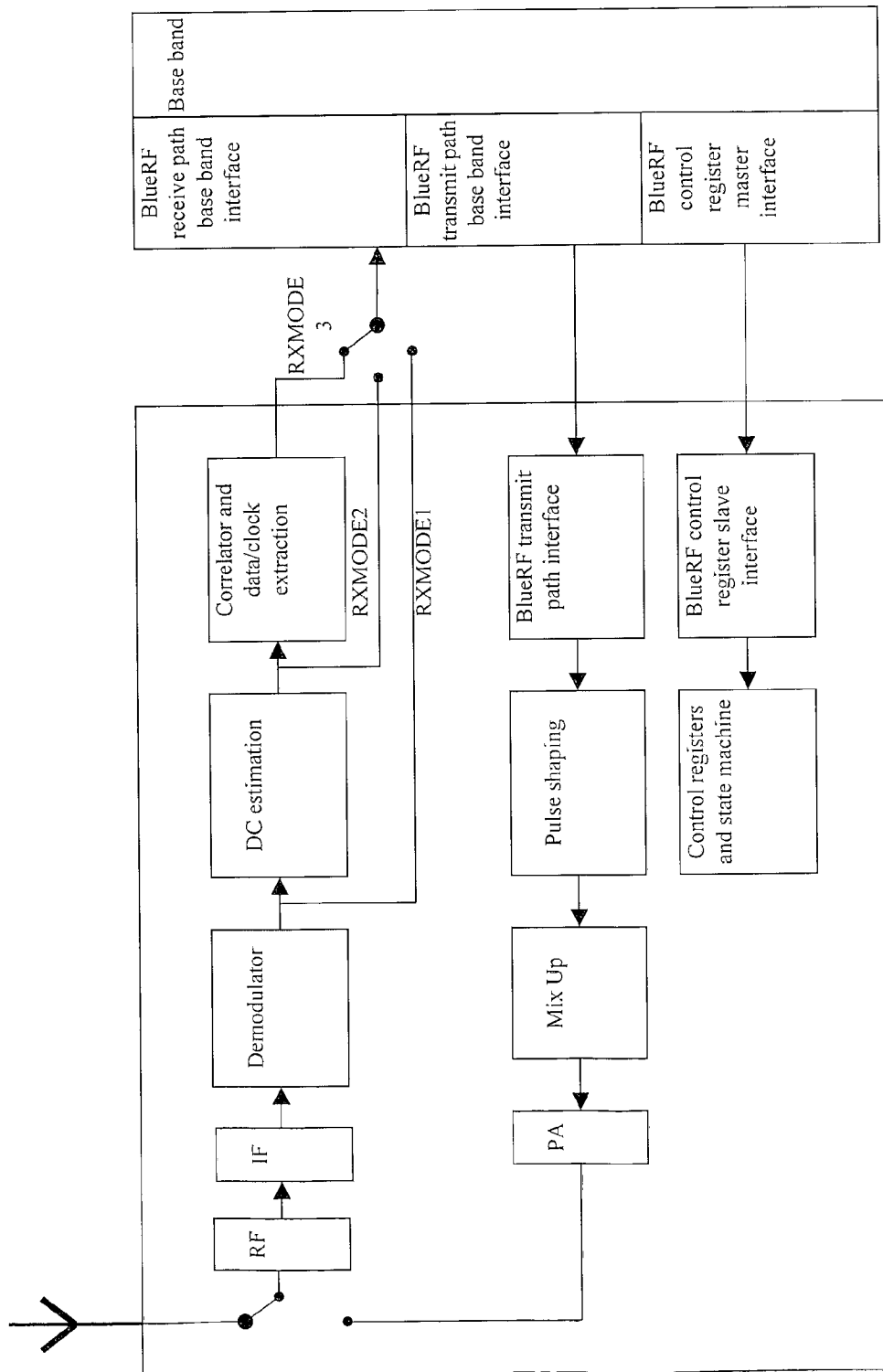


Fig. 1

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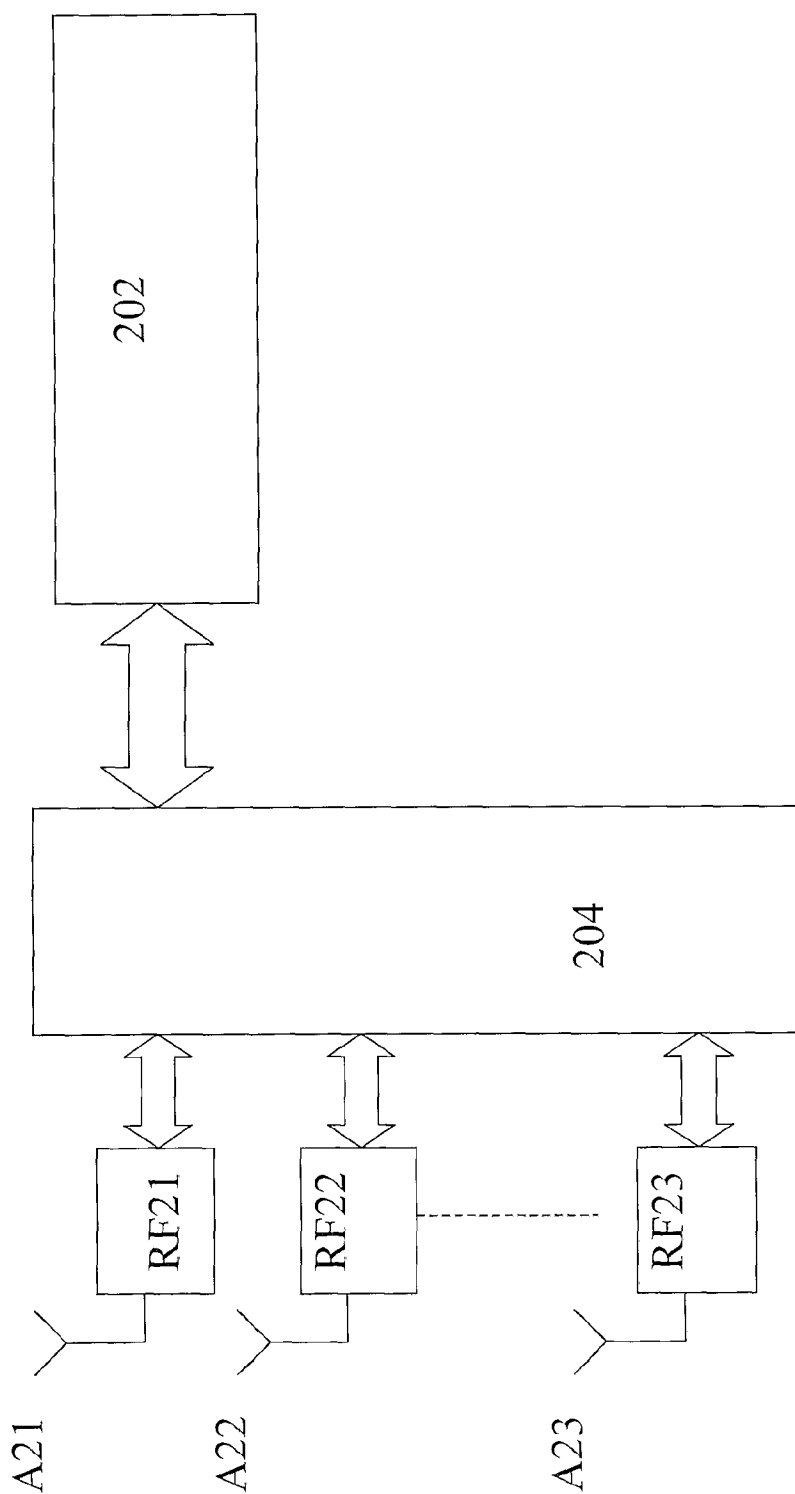


Fig. 2

3/11

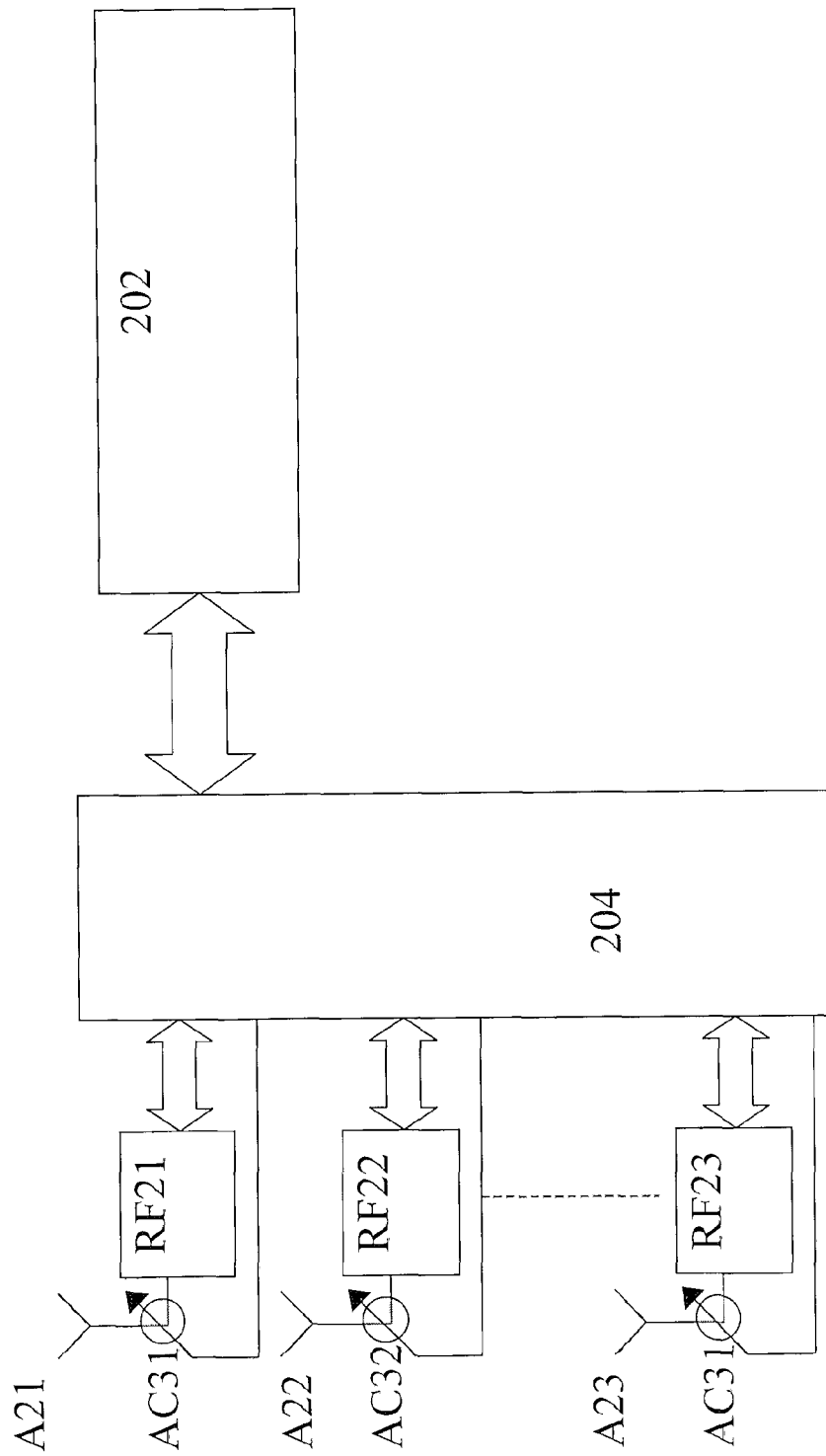
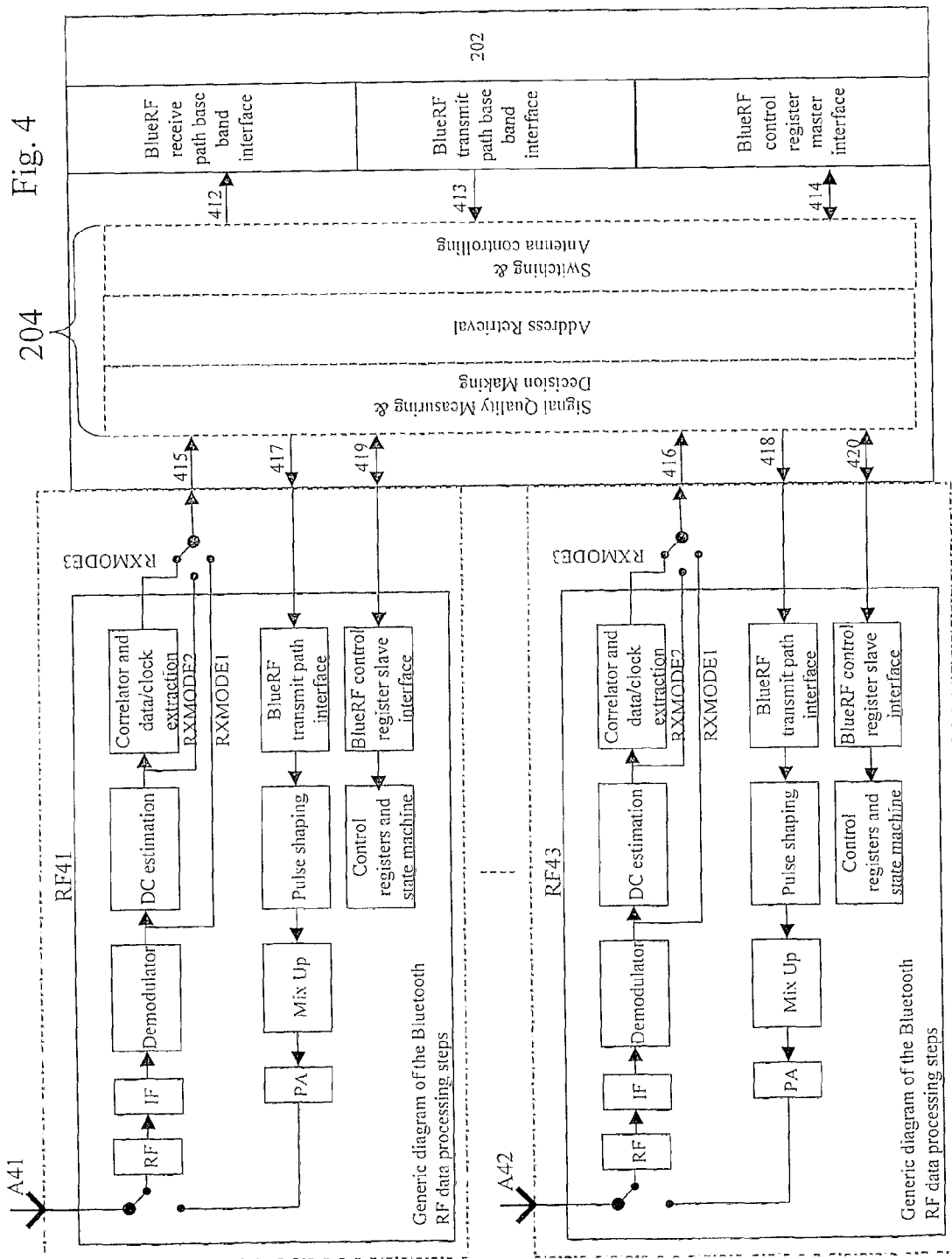


Fig. 3



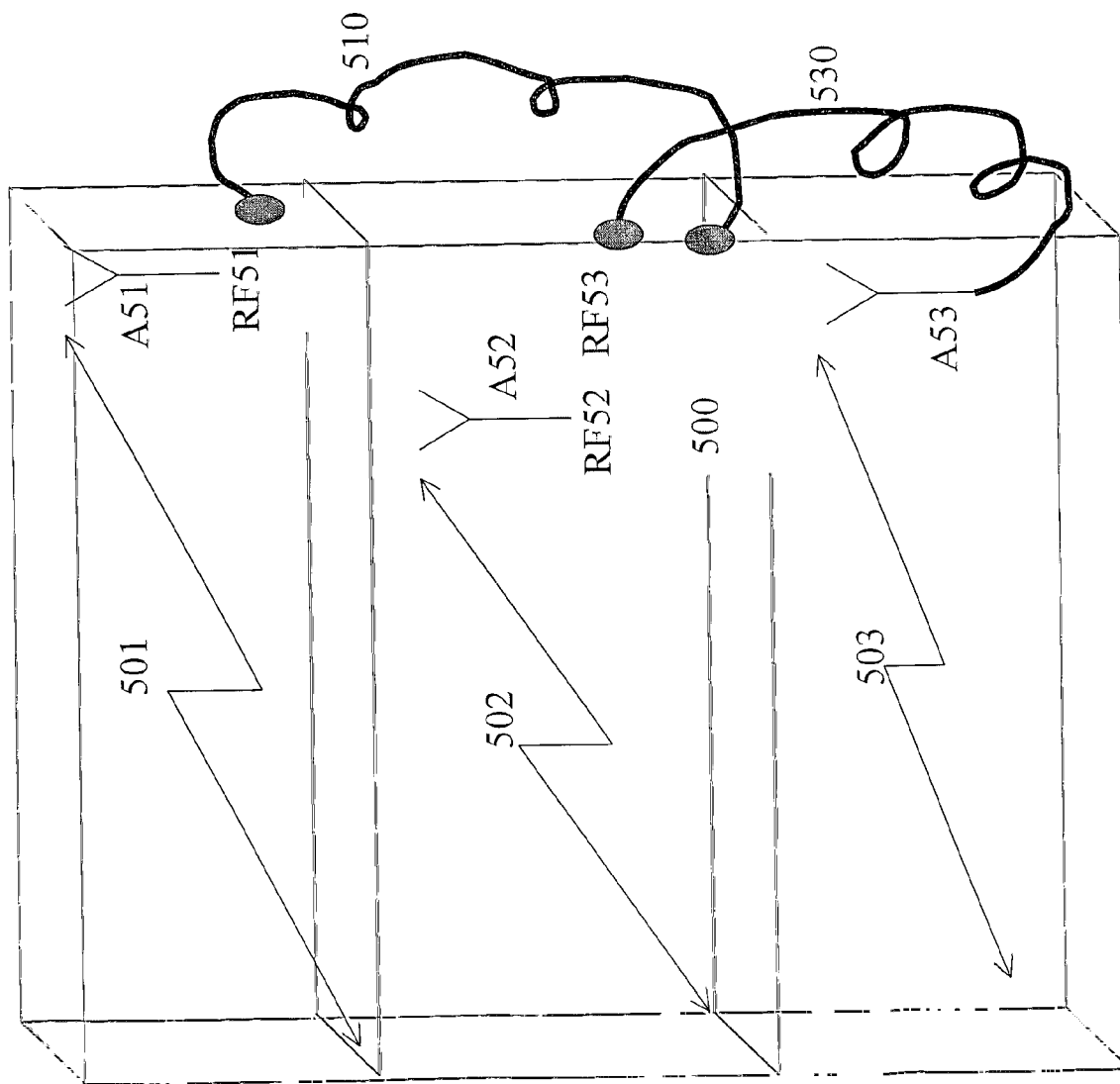


Fig. 5

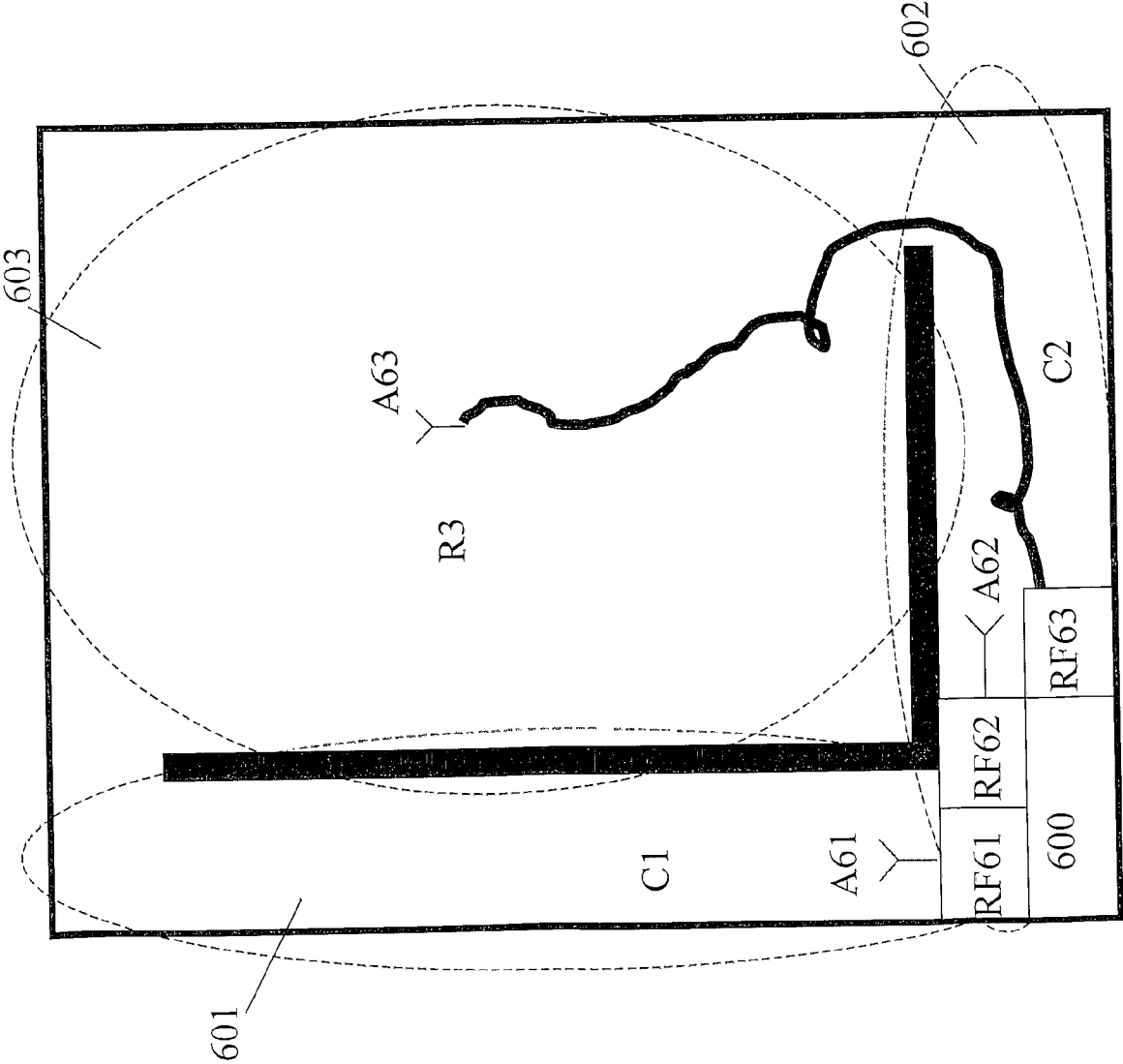
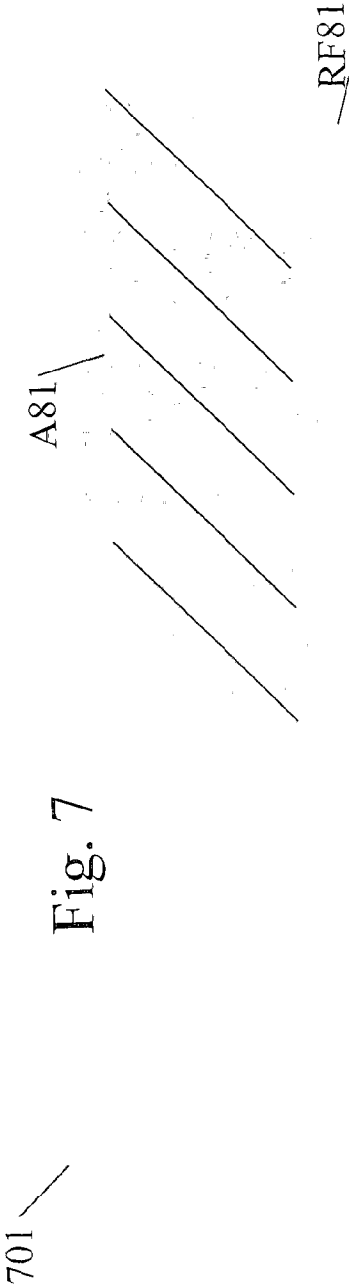


Fig. 6

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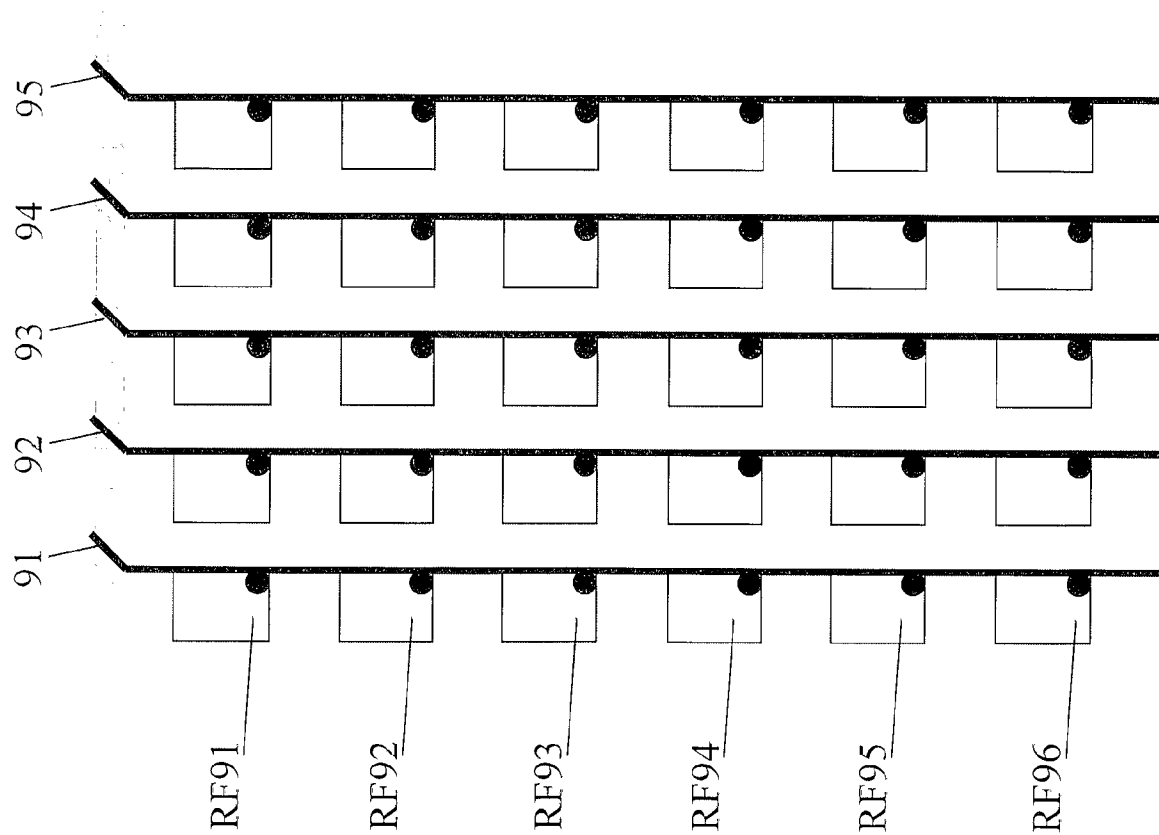


Fig. 9

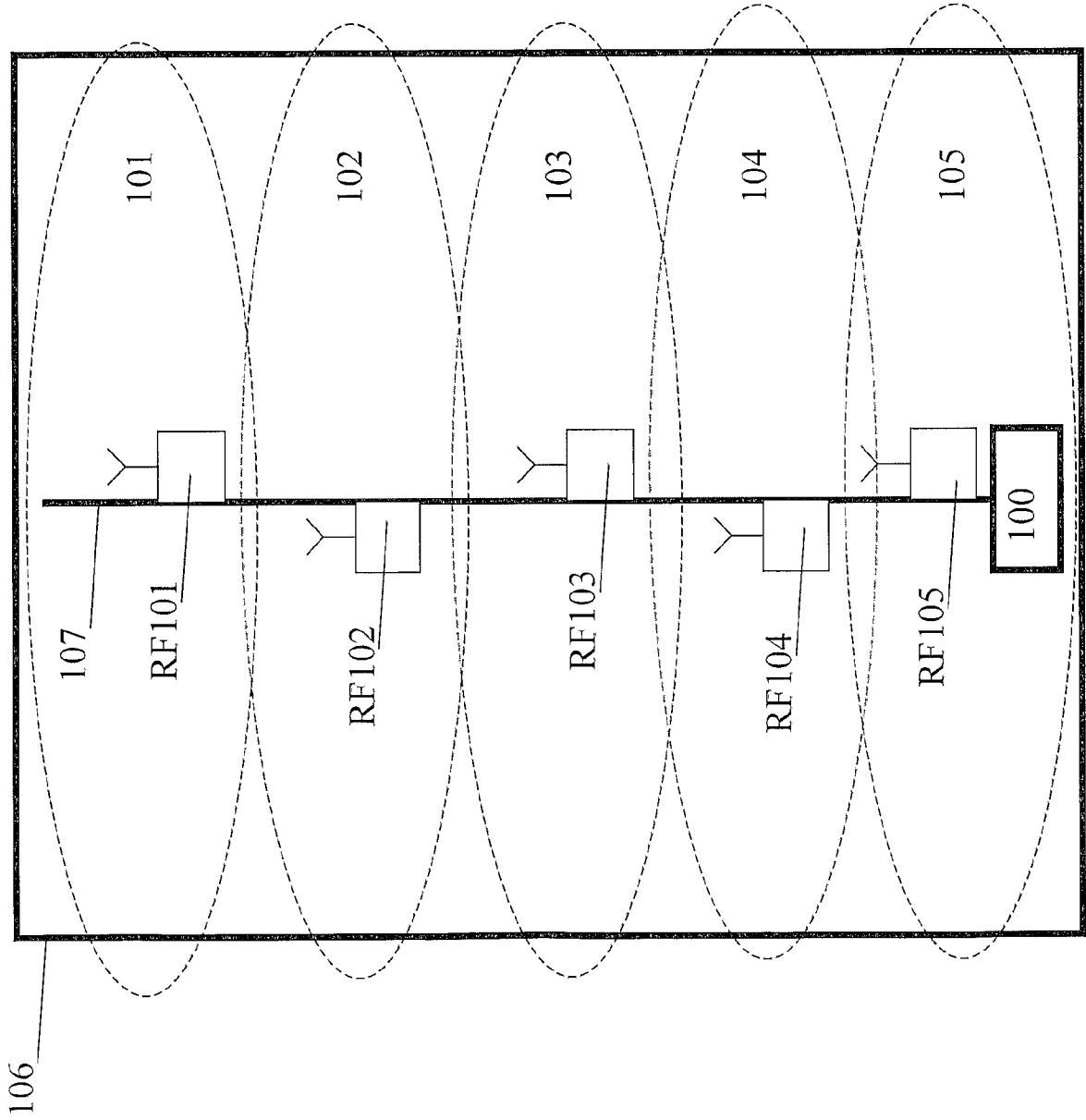


Fig. 10

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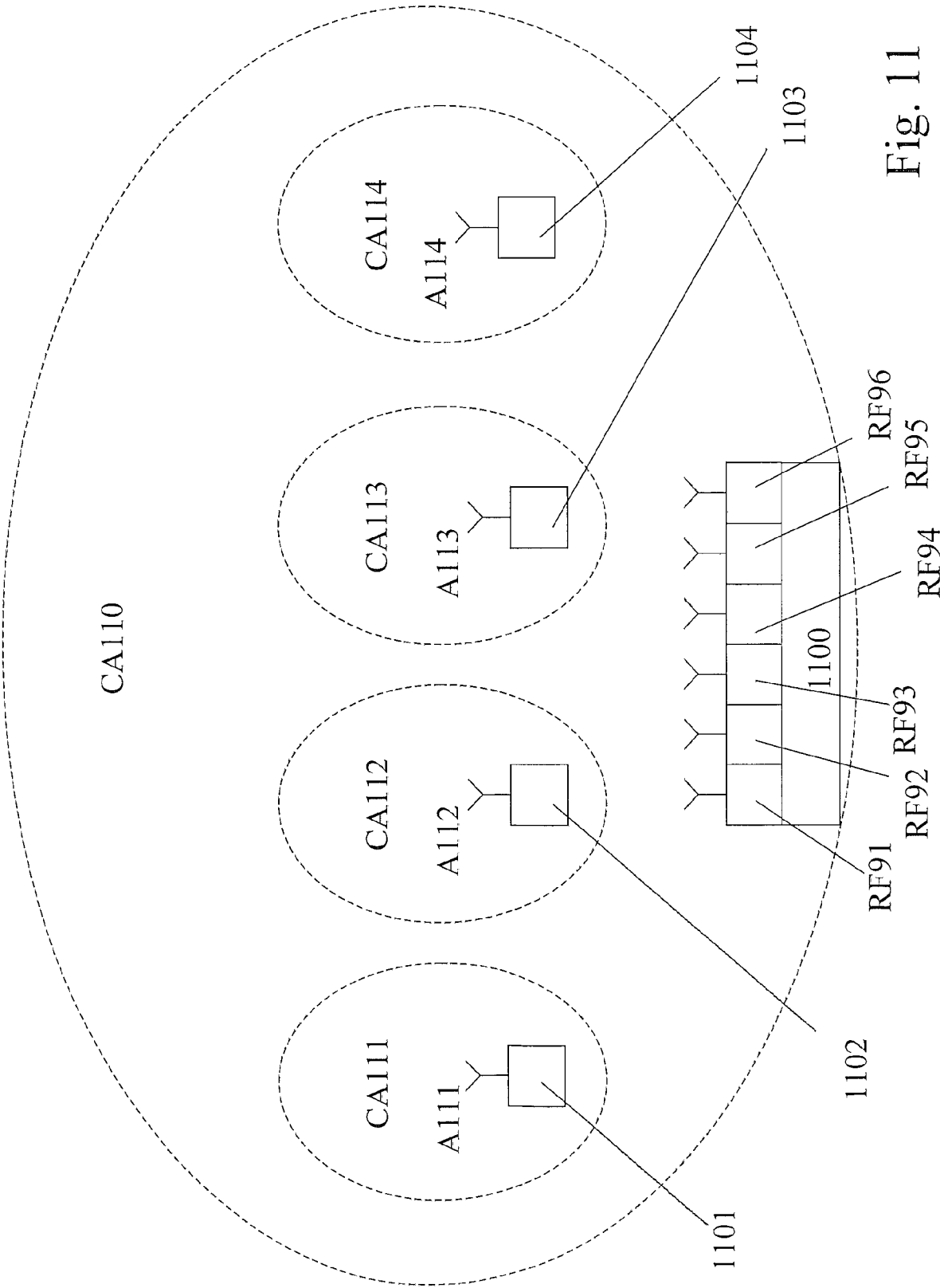


Fig. 11

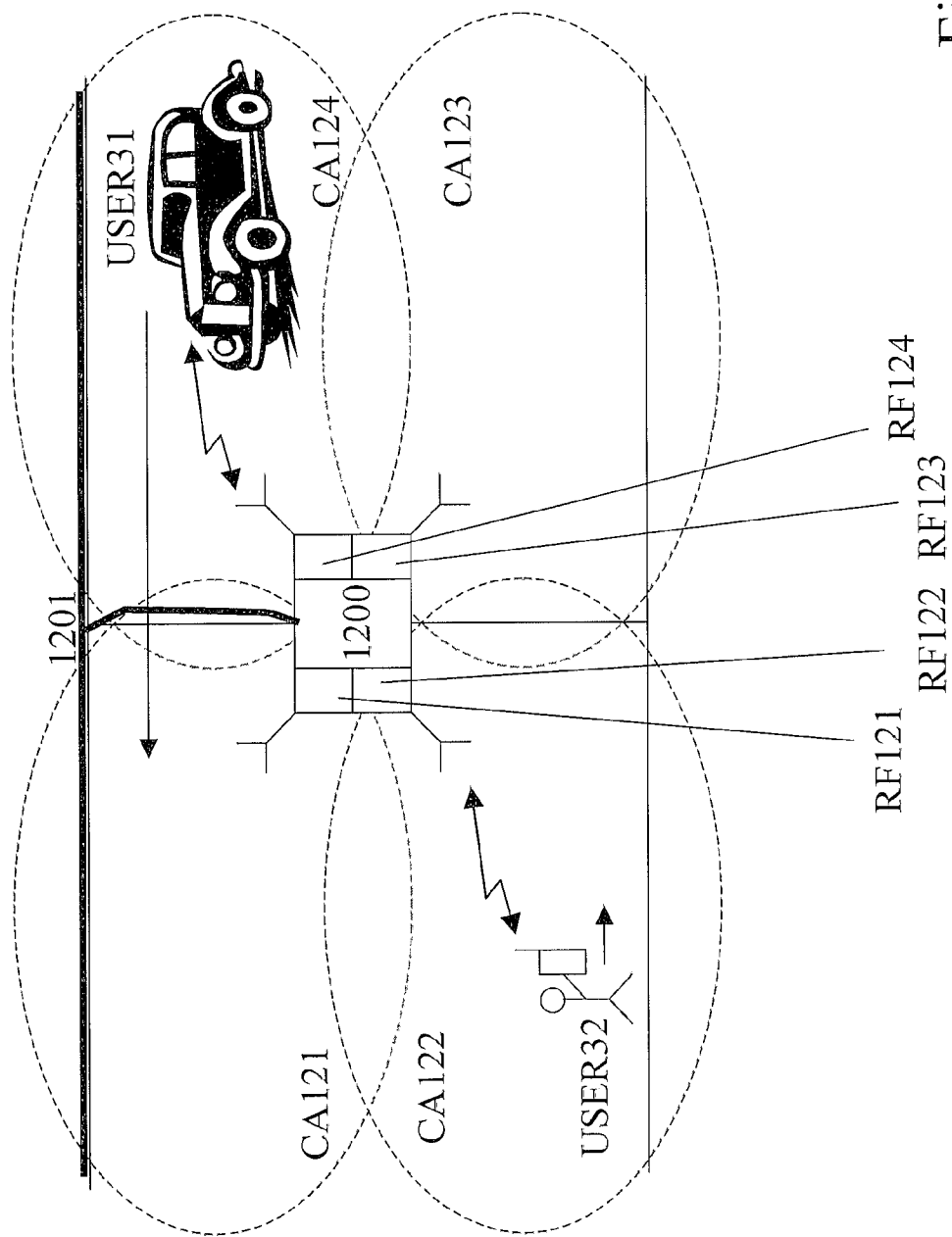


Fig. 12

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/00891

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/38, H04B 7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q, H04L, G08C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI DATA, EPO-INTERNAL, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5533023 A (JOHN OHLSON ET AL), 2 July 1996 (02.07.96), abstract --	1-25
Y	EP 0866628 A2 (AT&T CORP.), 23 Sept 1998 (23.09.98), page 2, line 32 - line 43; page 2, line 46 - line 49; page 3, line 9 - line 18, page 9, line 52 - 57; page 10, line 1 - 10; page 10, line 32 - 39; page 11, line 5 - 6; page 11, line 29 - 41; page 11, line 49 - 56; page 12, line 22 - 29; figures 2,3,5 --	1-25
P,Y	WO 0120940 A2 (NOKIA CORPORATION), 22 March 2001 (22.03.01), page 3, line 15 - line 29; page 4, line 1 - line 11; page 5, line 19 - line 24, figure 1 --	1-23

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

12 July 2001

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 01/00891

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	EP 0589753 A1 (ALCATEL RADIOTELEPHONE), 30 March 1994 (30.03.94), page 3, column 3, line 33 - line 45; page 3, column 4, line 24 - line 40; page 5, column 7, line 24 - line 37 -- -----	1-13

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/07/01

International application No.

PCT/SE 01/00891

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